Marigolds -- A Biological Control of Meadow Nematodes in Gardens

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Calendula plants grown in nematode-infested soil, left, and in soil where marigolds had previously grown.

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Parasitic nematodes are microscopic worms which feed on roots of many different plants. They cost farmers millions of dollars each year by damaging crops. How much damage is done by nematodes in flower and vegetable gardens around homes is not so well known. Farmers often use fumigant nematicides to control parasitic nematodes in fields, but these fumigants are difficult to use in small gardens.

Most parasitic nematodes feed on a wide variety of plants in a garden. For example, the meadow or root lesion nematode, *Pratylenchus penetrans* (Cobb) Allen and Sher, is widespread in Connecticut and throughout the Northeast. It has been reported around roots of over 70 different plants (4) including crops, trees, and weeds (7). The experimental work reported here indicates how much injury this nematode causes to garden crops and suggests practical measures of control that home gardeners can use to combat it.

Parasitic nematodes injure many but not all plants in the garden. This was shown in a simple experiment. The nematicidal fumigant D-D, which is a mixture of 1,3-dichloropropene and 1,2-dichloropropane, was applied to a plot of soil at the rate of 25 gallons per acre in the fall. The following spring, plants were grown in the fumigated soil and compared with similar plants grown in nonfumigated soil. As shown in Table 1, petunias (*Petunia hybrida* Vilm.), zinnias (*Zinnia elegans* Jacq.), eggplants (*Solanum melongena* L.), apples (*Malus* sp.), English ivy (*Hedera helix* L.), and euonymus (*Euonymus japanicus* L.), grew better when nematodes were controlled by the D-D. Better growth of petunias in fumigated soil is shown in Figure 1. However dahlias (*Dahlia variabilis* (Willd.) Desf.), and forsythia (*Forsythia* spp.) grew well in spite of nematodes in the soil. In another test strawberries (*Fragaria* spp.), tomatoes (*Lycopersicon esculentum* Mill.) and sweet peppers (*Capsicum frutescens* L.), but not sweet corn (*Zea mays* var. *saccharata* (Sturtev.) Bailey), grew better after fumigation. These results show that certain plants in the garden will benefit from fumigation and nematode control.

One might wonder how nematodes get into a garden. Since nematodes feed on many weeds, they may have been in the soil before the land became a garden. Nematodes can also come into a garden on soil or in roots of plants and then infest plants and weeds grown later in the garden. We found many meadow nematodes in soil around several weeds including

Figure 1. Growth of petunias where nematodes were killed by fumigation with D-D and in unfumigated soil containing meadow nematodes.

crabgrass (*Digitaria sanguinalis* (L.) Scop.), pigweed (*Amaranthus retroflexus* L.) and dandelion (*Taraxacum officinale* Weber) (5). Townshend and Davidson (7) found meadow nematodes very numerous around many common weeds and crops such as mouse-eared chickweed (*Cerastium vulgatum* L.), white and sweet clover (*Melitotus alba* Desr.), annual daisy-fleabane (*Erigeron annua* (L.) Pers.), and cabbage (*Brassica oleracea* var.

Table 1. Improving growth of plants around the home by controlling nematodes with a nematicide, D-D[a]

Plant	*No. years grown*	*Effect of nematicide on plants*
Petunias	1	Plants much larger, increased blossoming on June 8, 400% more bloom on July 21
Zinnias	1	Increased blossoming 55%
Eggplants	1	Increased plant size 25% and increased yields 45%
Dwarf dahlias	1	No effect
McIntosh apple trees	2	Increased shoot growth 47%
English ivy	2	Increased vine growth 85%
Euonymous	2	Increased shoot growth 66%
Forsythia	2	No effect

[a] D-D applied on October 1, 1964 at the rate of 25 gal/acre. Planting was done in the spring of 1965. Each type of plant was planted in four different rows.

capitata L.). Hence, control of weeds can reduce the rate of buildup of nematodes in garden soil.

We examined flowers as well as vegetables as hosts for meadow nematodes. Soil samples were taken in a garden where both flowers and vegetables were growing and where meadow nematodes were known to be present. Meadow nematodes were plentiful after zinnias, petunias, and tomatoes were grown (Table 2). Few meadow nematodes were found in soil where salvia or scarlet sage (*Salvia splendens* Ker-Gawl.) and dahlias had grown and very few meadow nematodes were found where either small marigolds (*Tagetes patula* L.) or large marigolds (*T. erecta* L.) had grown. The number of nematodes in each soil sample was determined. Then, to determine the stunting of plant growth by these nematodes, zinnia seeds were planted in the soil. After 6 weeks we determined the number of meadow nematodes present inside the zinnia roots, the amount of root injury, and the weight of the plants. The results are given in Table 2. During the 6 weeks the number of nematodes increased in all of the soil samples planted to zinnias except those in which a crop of marigolds had previously grown.

Zinnias grew best in soil that had grown marigolds. Yet nematodes were not the only soil factor influencing growth. Soil from areas that had previously grown beans or zinnias caused stunted growth of zinnia seedlings; yet meadow nematodes were much more numerous at planting time in soil that had grown zinnias than in soil that had grown beans. Beans and zinnias appear to produce residues or encourage organisms that injure zinnias planted later into the same soil.

In another experiment calendulas or pot marigolds (*Calendula officinalis* L.), cosmos (*Cosmos bipinnatus* Cab.), salvias, marigolds, nasturtiums (*Tropaeolum majus* L.), and zinnias were grown for 12 weeks in

Table 2. Meadow nematode populations in soil taken near different flowers and vegetables in a garden and growth of zinnias in these soils

Plant near which soil was obtained	*Number of meadow nematodes in 5 oz soil before zinnias were planted*	*Number of meadow nematodes in 1 gm of zinnia roots 6 weeks after planting*	*Root rating 1=best 4=worst*	*Average weight (grams) of zinnia plant after 6 weeks*
Large marigold (*Tagetes erecta* L.)	1	8	1.3	18.1
Small marigold (*Tagetes patula*)	2	2	1.1	17.0
Salvia	7	103	3.3	14.5
Tomato	47	116	3.0	14.4
Petunia	27	85	3.1	12.3
Dahlia	11	168	3.0	11.5
Large zinnia	35	79	3.1	7.3
Small zinnia	22	122	3.3	5.7
Bean	11	52	2.8	7.0

a soil that contained many meadow nematodes at planting time. Then samples of the soil were analyzed for nematodes. Meadow nematodes increased where zinnias and cosmos were grown but decreased in soils growing marigolds, salvias, and calendulas.

The use of marigolds as a nematode control measure has been examined in the Netherlands and elsewhere (2, 3, 6). The technique appears made to order for use around the home. We explored the value of marigolds for controlling nematodes in flower beds by growing various plants in soil in which marigolds had grown the previous year, in fumigated soil, and in nonfumigated soil containing many meadow nematodes. The fumigated soil was taken from plots that had been treated with 6 gallons per acre of the nematicide ethylene dibromide. Soil from the three areas was placed in pots and planted to tomatoes, petunias, snapdragons, calendulas, sweet williams (*Dianthus barbatus* L.), salvias, or foxgloves (*Digitalis purpurea* L.). Growth of the plants after 7 weeks was affected much the same by marigolds as by fumigation. Snapdragons grew much better in fumigated soil or in soil where marigolds had grown than in the soil containing many meadow nematodes (Fig. 2). Growth of petunias, sweet williams, and calendulas was better following marigolds than following other plants (Figures 3, 4, and cover). Plants grew bigger on the soil where marigolds had grown and where meadow nematodes were scarce (Table 3).

In another experiment, we compared the effects of (1) fumigation with ethylene dibromide, (2) the growth of marigolds and (3) crops of crabgrass, pigweed, rye (*Secale cereale* L.) and buckwheat (*Fagopyrum escu-*

Figure 2. Growth of snapdragons in untreated soil containing meadow nematodes (left), marigold soil (center), and fumigated soil (right).

Table 3. Growth of flowers and tomatoes in soil containing meadow nematodes and in soil in which marigolds had been grown

Plant grown	*Soil source*	*Average weight of above ground part of plant after 7 weeks*	*Number of meadow nematodes in a 2-inch section of root*	*Average height of plant*
		grams		*centimeters*
Petunia	marigold	4.8	0	30
	nematode infested	1.3	29	10
Sweet william	marigold	2.5	3	—
	nematode infested	0.4	23	—
Foxglove	marigold	5.8	0	—
	nematode infested	3.2	24	—
Zinnia	marigold	6.4	0	38
	nematode infested	0.9	34	18
Calendula	marigold	9.3	0	—
	nematode infested	6.0	11	—
Tomato	marigold	16	1	54
	nematode infested	6	15	30

ientum L.) on nematodes in soil and on crops planted later (5). The marigolds, rye, crabgrass, pigweeds, and buckwheat were grown in 1963 and fumigation was done on May 9, 1964. Tobacco was grown on these soils in 1964, 1965, and 1966. Privet (*Ligustrum vulgare* L.) was also grown beside the tobacco in 1964 and 1965. Tobacco plants were 50% bigger the first year on marigold soil and on fumigated soil than on soil where rye, buckwheat, crabgrass, or pigweeds had grown. Growth of tobacco was improved in marigold soil even in the second and third years. Privet grew 40% more shoots where marigolds had grown than where rye or buckwheat had grown.

The idea of interplanting marigolds with other plants has been suggested as a means of controlling nematodes while at the same time producing a crop. In a series of plots to study this experimentally, marigolds were interplanted with strawberries, tomatoes, or gladioli (*Gladiolus hortulanus* Bailey). Plants were 1 foot apart in the row. The interplanted marigold plants were started in the greenhouse and transplanted into the rows 2 weeks after transplanting the strawberries and on the same day that the tomatoes and gladioli were planted. Marigolds were also seeded broadcast on four plots where no other plants were grown.

In a parallel series of plots, strawberries, tomatoes, and gladioli were planted into soil previously fumigated with the nematicide Telone (1,3-dichloropropene and related C_3 chlorinated hydrocarbons), and applied at the rate of 25 gallons per acre 3 weeks before planting time.

It soon became apparent that the interplanted marigolds were acting like weeds and reduced the yields of strawberries below that in the untreated areas. Fumigation, however, increased yields of strawberries by 80% compared with unfumigated soil but did not increase the growth of gladioli or yields of tomatoes. By the end of the summer, marigolds, both

Figures 3 (above) and 4. Growth of petunia and sweet william in nematode-infested soil and marigold soil (right).

broadcasted or interplanted, had reduced meadow nematodes to less than 10% of the number in untreated plots.

The plots were rototilled the next spring and replanted to corn and petunias. The petunias grew 35% to 55% better where marigolds had grown or the soil had been fumigated a year earlier. Growth of corn was slightly stunted where Telone had been applied in the previous year.

Thus, growing marigolds suppresses meadow nematodes for up to 3 years and controls one or more other nematodes (5, 6) for 1 or more years without injuring other plants. An easy way to use marigolds for nematode control is to rotate plantings of marigolds with plantings that are susceptible to nematode injury.

If marigolds are interplanted 2 or more weeks after the other plants, competition is lessened. Interplanting with marigolds may not greatly benefit garden plants during the first season, but benefits become apparent the following year after the nematode population is reduced. Interplanting has the advantage of providing flowers (marigolds) and another flower or vegetable crop while the meadow nematode population is being reduced. Gillespie (1) discusses interplanting of roses and marigolds for control of pests. She suggests that marigold buds may be clipped if the smell of the flowers is objectionable.

Marigolds control nematodes by producing a chemical in the roots which kills nematodes when it is released in soil (8). This chemical is produced slowly and so marigolds must be grown all season to give lasting control. They cannot be grown for a few weeks before or after some other plant and give lasting control.

Summary

Meadow nematodes injure many plants around the home. Control of these nematodes results in better flowers and more fruit and vegetables from the garden. Chemical control of nematodes in a small garden or around a few established plants is generally impractical. Nematicides are not ordinarily available in the small amounts needed to treat a garden, equipment to apply them is designed for large areas, and most volatile nematicides injure plants that they touch. Growing of marigolds controls meadow nematodes as long as 3 years. Rotating marigolds with plants injured by meadow nematodes or other nematodes provides both flowers and nematode control.

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